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ABSTRACT

This paper discusses research on how concepts differ in their internal organization and how these differences interact with and affect cognitive processing in children. Two types of natural concepts are focused on: classes (nouns with class-inclusion organization, such as "trees," "students," "soldiers" and collections (nouns with part-whole structures, such as "forest," "army," "class," "team"). Collections are said to have a greater psychological integrity and to be easier to conceive as an aggregate or organized totality than classes. To test the psychological reality and implications of this distinction, several tasks that require treating objects as organized into aggregates rather than as individuals were given to children. Children's ability to answer the Piagetian class inclusion problem was considerably improved when the question was phrased in terms of collection rather than class labels. Similarly, children's performance on the number conservation problem was improved when the objects were described as collections rather than classes. Collection labels allowed children to use the cardinality principle on a number problem which they otherwise would have failed. These results indicate a relation between how children organized or represent information and their subsequent ability to operate on that representation. The problem on these tasks is that children do not have the ability to impose the appropriate organization, not that they need to be taught new skills. Details of the research are not provided. (Author/SS)

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Classes, Collections, and Principles of Psychological Organization

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My research is concerned with how concepts differ in their internal organization and how these differences interact with and affect cognitive processing in children. This is a much more specific focus of research than the other approaches to be discussed today. It is not applicable to any conceivable problem in cognitive development but instead is concerned with a more delimited set of issues. After describing the issues and how I have addressed them, I speculate about how some of the findings that arise from this work, relate more generally to cognitive development.

I have been especially interested in two types of natural concepts, classes and collections because they differ in their principles of organization. My research has attempted to discover whether there are any interesting psychological consequences to these differing principles. Before describing the research, let me summarize some of the differences between these two types of concepts. Examples of the collection-class contrast are forest vs. trees, army vs. soldiers, class vs. student, pile vs. brick, team vs. players. I have called forest, army, class, team, etc. "collections" because they are the referents of collective nouns. I have called trees, soldiers, students, etc. "classes" to emphasize their class-inclusion organization.

Classes and collections differ in several related ways: collections are organized into part-whole structures compared to the class inclusion or class membership relation of classes. An oak is not a forest, it is a part of a forest; a general is part of an army. In contrast an oak is a tree, it is a kind of tree, an example of a tree, etc. This is a standard class inclusion relation. Another difference between classes and collections is in the interrelationship of the members. To know whether a tree is in a forest requires knowledge about its relation to other trees in the forest. In contrast to know

whether a potential tree is a tree requires information about the properties of the object. No information about its relation to other trees is needed. Thus, collections have an internal organization or structure that classes lack. As a consequence of these internal structures, collections form psychologically more coherent units than do classes. Collections have greater psychological integrity and are easier to conceive of as an aggregate or organized totality than are classes. This does not mean that one cannot notice individual items under a collection organization. When physically separate, discrete objects are involved, it is relatively easy to perceive objects as individuals. What is difficult is to impose a higher order structure onto the perceived individuals. When it is relatively easy to individuate physically separate objects but relatively difficult to also think of them as organized into an aggregate, a collection organization should be beneficial. This advantage might be especially great for children since there is some evidence that they have difficulty taking advantage of class inclusion taxonomics; e.g., for categorization and memory tasks.

To test the psychological reality and implications of this distinction, I have looked for tasks that require treating objects as organized into aggregates rather than as individuals. One such task is the Piagetian class inclusion problem. In this task, children are asked to make a quantitative comparison between a superordinate set and the larger of two subordinate sets. For example, children are shown displays of seven roses, and three daisies and asked, "Are there more roses or more flowers here?" Young children incorrectly answer "roses." This division of the superordinate class into two subordinate classes weakens the psychological integrity of the superordinate class. So the child's problem is that he cannot keep the whole class in mind while simultaneously attending to the subclasses. Instead of making the part-whole

comparison children err by making a part-part comparison instead. If collections form better psychological wholes, have greater psychological integrity than classes, then children should be able to maintain the whole collection in mind while focusing on its subparts. In fact, children can solve part-whole comparison problems with collections they fail with classes. For example, children were shown four boy dolls and two girl dolls. For class descriptions they were told that the dolls were "kindergarten children" and asked "Who would have a bigger birthday party, someone who invited the boys or someone who invited the children?" As usual, children found the question difficult. Their ability to answer the question was considerably improved when they were given the collection label "kindergarten class" and asked "who would have a bigger birthday party, someone who invited the boys or someone who invited the class?"

Another domain in which I have been contrasting the collection and class organization is in problems having to do with cardinal number. Cardinal number applies, not to individual objects but to aggregates. The specific number associated with a set of elements is a property of the set, not a property of the individual elements themselves. "There are ten men" does not imply that any individual man is ten. Rather the set has the cardinal number ten. When ten is attributed to "men" it is to men as a group and not to the individuals that make up the group. Of course individuals must be counted or otherwise enumerated to calculate the numerical value of a set. But it is not enough to focus on the individuals. One must also consider the set taken as a whole. Since collections should promote conceptualization of individual objects as aggregates and since cardinal number applies to aggregates not individuals, collections should facilitate numerical reasoning about discrete objects.

To test this hypothesis I have examined children's performance on several number tasks that they are known to have difficulty with. The best known

problem is number conservation. In this problem children are presented with two equal rows of objects lined up in one to one correspondence. Four to five year old children typically judge that the rows are the same number of objects. Yet if the objects in one of the rows are spread out children often judge the lengthened row to have more. In one study I have found that children are better able to conserve number when the objects are described as collections. For example, children are told "these are your soldiers, these are my soldiers, what's more, my soldiers, your soldiers, or are they both the same?" Then one row is spread and the question repeated. Children judge the lengthened row has more. When shown an identical set of soldiers and transformations but told, "this is your army, this is my army, what's more my army, your army, or are they both the same?" They correctly answered "the same."

Another number problem in which there are developmental differences is in providing the cardinal number of a set. When young children count objects and then are asked "how many are there?" they often respond by counting again rather than by stating the number. This is a failure to use the cardinality principal which involves understanding that the last number in the count series becomes the cardinal number of the set. Again children must have the appropriate aggregate structure to which to attach the cardinal number. By helping children conceptualize the array as an aggregate we might be able to promote their use of the cardinality principle. Again, collection labels allowed children to use the cardinality principle on the task where they otherwise would have failed. For example, we showed children five soldiers and said, "Here are some soldiers. Count the soldiers." The child counts, one, two, three, four, five." How many soldiers are there? Child counts again "one, two, three, four, five." When we said "Here is an army. Count the soldiers in the army." The children counted, but when we said "how many soldiers are in the army" the child was significantly more likely to answer

"five" rather than counting again.

For both class inclusion and number problems I have argued that the problem is not in encoding the spatially discrete objects as individuals but rather in imposing a higher order organization on the individuals. Because class terms are congruent with perception at the level of the individual, they provide no aid to the child in structuring the group. Collection terms help by guiding the children to the appropriate unit of analysis, the aggregate.

Now let me return to the general question of what is different about this approach and what implications it has for studying cognitive development. First, the issue of the effects of organization on cognition and developmental changes in organization is an old and important issue. What is different about the present way of studying it, is that no literal reorganization ever takes place. Nothing analogous to random versus categorized word lists is used here. The perceptual input is always identical in the two conditions. It is simply the labels that differ.

Second, the work emphasizes the relation between how children organize or represent information and their subsequent ability to operate on that representation. Young children may require a greater fit between the representation upon which they operate and the nature of the operations.

Third, to my knowledge, there has been little investigation of this particular organizational contrast, part-whole versus inclusion. Yet, it seems to me that it may be a contrast that is of considerable interest, at least in children's cognition. These differing principles of hierarchical organization affect children's reasoning in both class inclusion and number, two areas of importance in cognitive development.

Finally, it is the goal of much developmental research to discover how to improve children's performance, how to simplify task demands to reveal

underlying competencies of children and to better understand what develops. What is unique about this approach is that the manipulation is much more subtle than those usually required for comparable improvement. I see no way in which the relabling could be construed as providing the child with knowledge he did not already have. I have not trained any new skills, I have not taught any new terms, I have not changed the complexity of the stimulus material or simplified the problem in any other way. This indicates, that there are already existing abilities children have that the typical task obscures. And this is because the child does not have the ability to impose the appropriate organization. This relabeling helps the children shift the organization they impose on the material from inclusion to part-whole relations and thus allow them to accomplish tasks they otherwise would fail.